NE 95-10a

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Subject: Evaluation of the McFarland TS for annosus root disease (FPM Rpt. Number NE95-10a)

To: District Ranger, Quincy RD, Plumas NF

On June 22, Ron Clark and Dennis Clemens, Quincy Ranger District, and Bill Woodruff, Forest Pest Management, visited Units 17, 2 and 6 in the McFarland Project. The objectives of the site visit were to examine areas of white fir mortality, to confirm the presence or absence of annosus root disease, and to provide Forest Pest Management input to the silvicultural prescription for the units. Annosus root disease was suspected in the white fir in several small sites in the planning area. Three mortality centers had been identified by Ron Clark, one in each of the three units. Additional visits to the areas were made by Bill Woodruff on July 3, and by Bill Woodruff, John Kliejunas (R5 FPM), and Dennis Clemens on July 18.

The area is located approximately 4 miles southwest of Meadow Valley, California in T23N, R8E, within all or portions of Sections, 2, 3, 4, 5, 7, 8, 9, 10, 11, 15, 16, 17, 18, and 20.

Elevations range from 4,200 ft. to 5,700 ft. The average is about 5,000 ft. Geology is variable. Granitics, metamorphics, and pyroclastic mudflows are present in the area. Precipitation is estimated to average 65 inches in a combination of rain and snow. Productive capacity of the majority of soils is in the upper one-third of the scale. The mixed conifer series and white fir series of ecological types intergrade in this area, with the white fir series dominating at the upper elevations. The red fir series occurs in a small area in the southwest corner at the highest elevation.

Except for stand 12, which is red fir type, all stands proposed for thinning are composed of about 97% white fir, 2% incense-cedar, and 1% sugar pine. The potential natural vegetation in this area is the White Fir Mixed Conifer/Creeping Snowberry/Kellogia type, which is described on pp.70-71 of the "Ecological Guide to Mixed Conifer Plant Associations for the Northern Sierra Nevada and Southern Cascades," by Jo Ann Fites, 1993. The stands proposed for thinning emerged through brushfields, perhaps as a result of stand replacing fires caused by the extensive mining activity in the area in the last century. Skeletons of brush can still be observed in the younger stands. Stand ages range from 61 to 104 years, with an average of 76. Site is Dunning class I or IA; Forest Survey Site Classes 2-3. Stand density indexes range from a low of 241 to a high of 562, with an average of 376. Full stocking for the mixed conifer type is SDI 479. Most of the stands are within Langsaeter's zone III, which for the mixed conifer type spans 300 to 480 SDI. Zone III is optimum for

thinning. The vast majority of stands are strata types M3N. Two stands are M3P and one is M2N. Quadratic mean diameter ranges from 12.7 inches to 22.1 inches, with an average for all stands of about 16 inches.

The management objective for the units is to increase/maintain fir growth in the stands since the stands will continue to be part of the Forest timber base. To meet this objective, the silvicultural prescription for the McFarland area is to thin the stands twice over approximately 20 years before final harvest. It will be necessary to follow CASPO guidelines (CA Spotted Owl) in determining the size and numbers of trees to retain in the stands.

Observations

In Stand 17, a mortality center, approximately one acre in size, was observed. Many of the dead white fir had broken tops or had blown down. The roots of the windthrown trees had a laminated rot, typical of annosus root disease in true fir (caused by the S-type of the fungus Heterobasidium annosum). Fresh conks of H.annosum were found, confirming the presence of the disease. White pocket rot and several very old annosus conks were found. Annosus root disease was also present on white fir in other portions of the stand, killng individual trees or small groups of trees. About 90% of the white fir stumps examined had laminated decay. However, only a few of the stumps had internal decay of the heartwood, indicating that the annosus infection occurred after the stumps were created.

In Stand 2, several discrete annosus root disease centers and scattered mortality of white fir were observed. Conks of H.annosum, laminated decay, and white pocket rot characteristic of the pathogen were common. Several white fir adjacent to the annosus centers had thinning crowns and reduced growth, typical of root infection.

Stand 6 had one discrete annosus root disease center. Other scattered white fir mortality was present. Several old H. annosum conks and laminated decay was observed.

No evidence of group kill from insect attack of drought-stressed trees was observed in any of the units. No evidence of annosus root disease on the pines or incense-cedar was observed. Other insects and pathogens observed in the stands included fir engraver (Scolytus ventralis) on white fir; mountain beetle (Dendroctonus ponderosae) and red turpentine beetles (Dendroctonus valens) on one sugar pine; true fir dwarf mistletoe (Arceuthobium abietinum f. sp. concoloris) on white fir; white pine blister rust (Cronartium ribicola) on several sugar pines; and incense-cedar rust (Gymnosporangium libocedri). Armillaria sp., as evidenced by the presence of rhizomorphs and mycelial fans, was observed, probably as a secondary decay to H. annosum, on dead white fir on the ground.

Discussion and Prognosis

Mortality patterns and signs and symptoms diagnostic for H. annosum in the units indicate that annosus root disease is primarily responsible for the observed crown symptoms, mortality and blowdown. Although some, limited,

mortality of white fir saplings and small poles was probably due only to overstocking and moisture stress, no evidence of group kill from insect attack of drought-stressed trees was observed in any of the units. Fire scars, along with the creation of stumps during periodic salvage logging, have resulted in levels of H. annosum that are relatively high, even for true fir stands.

Levels of annosus root disease will increase with proposed thinning if preventive measures are not taken. The thinning will result in the creation of additional stumps to serve as infection courts for H. annosum and, if done carelessly, the stand entries will result in wounding and scaring of the residual white fir, creating additional infection courts. Increased levels of H. annosum in the units will result in decreased growth rates, additional blowdown, and more stand openings not capable of supporting white fir. Data from Oregon demonstrate increasing levels of, and true fir mortality from, H. annosum with increasing numbers of stand entries. The same would likely occur in the McFarland units if preventive measures are not taken.

Annosus Management

The biology and resource management implications of annosus root disease in California, and management strategies available for reducing its impact, are contained in FSH 3409.11, R5 Supplement No. 3409.11-94-1 (see Appendix). A brief discussion of management options available specifically for the McFarland units in relation to the management objectives for the area follows.

Conifer Stump Treatment

Once annosus root disease becomes established in forest stands, no economically feasible procedure for directly suppressing the disease is available. Therefore, prevention is the most efficient and economical method of reducing H. annosum impact. Treatment of freshly-cut pine and true fir stump surfaces with borate compounds effectively prevents infection by airborne spores of H. annosum. The borate penetrates the stumps to a depth of several inches, and remains toxic to the spores for approximately 2 years. The chemical prevents infection by preventing germination of the spores; it has no effect on existing infections.

Several surveys have confirmed the benefit of borate application to pine stumps in eastside pine type stands. The efficacy of treating true fir stumps with borate to prevent future impact of the disease in a stand is less certain for several reasons. The pathogen can enter true fir through logging wounds and fire scars, and true fir are often infected with the fungus before stand entry. In addition, above ground crown symptoms indicting current levels of the fungus in the stand are often lacking. For these reasons, the decision to treat true fir stumps in timber stands with borate should lie with the appropriate line officer who has been fully briefed on the specific situation in the particular stand in question.

Policy regarding lower limits of stump diameter to treat with borate varies by forest and district, depending largely on historical information, current observations, and other considerations. The decision as to what lower stump diameter limit to treat with borate should be based on the risk the forest or

district is willing to take versus the cost of the borate treatment. The recommended 12 inch lower limit is based on field observations only rarely indicating H. annosum spreading from smaller diameter, chain saw-created, pine stumps and causing active annosus root disease centers.

Currently, Sporax[R] is the only borate compound registered in California for conifer stump treatment to prevent annosus infection. The label and Material Safety Data Sheet (see Appendix) contain information on the proper use and on the relative toxicity.

Avoiding Cambial Damage

True fir stands in California will experience substantial volume losses from decay if wounding of residual trees is not minimized during stand entry. in addition to creating infection courts for H. annosum and other decay fungi, wounds may activate dormant fungal infections. The location of the wound determines which decay fungi gain entry and how rapidly decay occurs. Procedures are established to reduce logging injury (Ahoe, P.E., G. Fiddler, and M. Srago. 1983. How to reduce injuries to residual trees during stand management activities. USDA Forest Service, PNW Experiment Station, General Technical Report PNW-156. 17 p.).

If you need further Forest Pest Management input, please contact me at (916) 257-2151, or by DG at B.WOODRUFF:R05F06A.

Bill Woodruff

BILL WOODRUFF
Plant Pathologist

Enclosures: FSH reference, Sporax label and MSDS

FOREST SERVICE HANDBOOK
San Francisco, CA

FSH 3409.11 - FOREST PEST MANAGEMENT HANDBOOK
R5 SUPPLEMENT 3409.11-94-1
EFFECTIVE 5/17/94

CHAPTER 60 - MANAGEMENT OF SPECIFIC PESTS

62 - DISEASES.

62.2 - Other Diseases.

1. Introduction to Annosus Root Disease. This section describes annosus root disease in the Pacific Southwest Region, and discusses the biology and resource management implications of the disease. It also presents guidelines and techniques for its detection, and management strategies available for reducing its impact.

Annosus root disease is one of the most important conifer diseases in the Region. Current estimates are that the disease infests about 2 million acres of commercial forest land in California, resulting in an annual volume loss of 19 million cubic feet. Potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of production on the site, and, in recreation areas, depletion of vegetative cover and increased probability of tree failure and hazard. In recreation areas, annosus-infected trees are often extremely hazardous, causing death or injury to visitors, and damage to permanent installations and property.

The goal of annosus root disease management in the Region is to reduce resource losses to levels which are economically, aesthetically, and environmentally acceptable when measured against the objectives of the resource manager. It is possible to reduce the impact of annosus root disease through detection, evaluation, prevention, and suppression. These activities must progress in a planned, timely sequence for successful reduction of annosus root disease impacts. Detection and evaluation in individual stands are normally necessary before undertaking prevention and suppression action. In developed recreation sites, early recognition and removal of hazardous annosus-infected trees is critical, and will greatly improve chances of preventing future damage with minimal site deterioration. Prevention is the most desirable means of reducing losses. Undertake suppression activities only when needed to supplement prevention measures. The basic guidelines for detection (FSM 3410), evaluation (FSM 3420), prevention (FSM 3406.1) and suppression (3406.2) for any insect or disease also pertain to annosus root disease. However, consider the additional specific guidelines for annosus root disease summarized in this section.

Annosus root disease occurs on a wide range of woody plants. The disease affects all western conifers; hardwoods are generally resistant or immune. All the National Forests in Region 5 have reported finding it. Incidence is particularly high on Jeffrey pine in southern California recreation sites and on Jeffrey and ponderosa pine in eastside pine type forests. The disease, endemic in the Red and White Fir forest types, is

associated with one-fifth or more of the true fir mortality in the forests surveyed in northern California.

2. Biology.

a. Heterobasidion annosum (Fomes annosus) causes annosus root disease. The fungus is similar to the common heartrot fungi, and forms fruiting bodies or conks in decayed stumps, under the bark of dead trees, or, rarely, under the duff at the root collar.

Infection centers start when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds on the butt. Fresh basal wounds on species other than true fir are rarely colonized. The fungus grows down the stump into the roots and then spreads through root contacts into the root systems of adjacent live trees, resulting in the formation of enlarging disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but is more frequently confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss, or failure at the roots. References that discuss the biology and disease cycle of H. annosum include Otrosina and Cobb 1989, and Smith 1993.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of H. annosum have distinct differences in host specificity. To date, all isolates of H. annosum from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense-cedar, western juniper, Pinyon, and manzanita are of the 'P' group. Isolates from true fir and giant sequoia are of the 'S' group. The biological species infecting other hosts are unknown at this time.

This host specificity is not apparent in isolates occupying stumps, with both the 'S' and 'P' groups recovered from pine stumps, and the 'S' group and occasionally the 'P' group from true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers of a species that is susceptible to the particular intersterility group established near these stumps often die shortly after their roots contact infected roots in the soil.

Invasion of freshly cut stump surfaces by germinating spores is a critical stage in the disease cycle. Conks produce spores which disseminate throughout the year, but H. annosum is dependent on favorable environmental conditions for successful

germination and establishment. Spores are inactivated by ambient temperatures of 113° F (45°C) and mycelium in wood is killed after exposure for one hour at 104° F (40°C). Temperatures just below the stump surface commonly reach or exceed the thermal inactivation level (40° C) of mycelium from April to September in the Southeastern United States. In eastside pine on the Lassen National Forest, lethal temperatures reach above 40°C in the top 6 inches of 6-inch diameter stumps when exposed to direct sunlight for several days in the average summer. Temperatures do not approach the lethal range in larger size classes of stumps.

Stumps are susceptible to infection immediately after cutting. Ponderosa pine, Douglas-fir, and coast redwood stumps remain susceptible to infection for 2 to 4 weeks. The decrease in susceptibility with time is probably a result of colonization of the stumps by microorganisms that compete with and replace H. annosum. Surface area infection of freshly cut ponderosa pine stumps increases with increased photochemical oxidant injury.

Vertical penetration depends on temperature and extent of injury from other sources. After germination, vertical penetration into pine stumps averages 3 inches/month from October through May and 5 to 6 inches/month from June to October. The rate of vertical penetration in stumps from pine trees severely injured by photochemical oxidants is greater than in those from slightly injured or uninjured trees.

Heterobasidion annosum is an important agent predisposing conifers to bark beetle attack. In pines, the fungus weakens trees and increases their susceptibility to pine bark beetles. Infected true firs are predisposed to attack by the fir engraver. White fir mortality from the annosus root disease-fir engraver complex frequently occurs after tree growth decreases because trees are stressed. As a result of the stress, it is suspected that roots grow very slowly and decay faster than the tree can replace them. This predisposes the tree to fir engraver attack, and causes its death.

3. Detection. The general distribution of annosus root disease in the Pacific Southwest Region is known, but information on its location in specific stands may be needed. Based on Region-wide surveys, it is prudent to assume that the pathogen is present in all true fir stands, unless a detailed survey suggests that it is not. Collect location information for stands when planning management activities. Because trees affected by annosus root disease are easily windthrown or fall without visible symptoms that might warn forest recreation managers of impeding failure, the number, size, and locations of annosus infection centers within developed sites or sites planned for development should be determined. Field surveillance and detection surveys will locate occurrences of H. annosum.

4. Field Surveillance. Forest workers and managers, in connection with their regular duties, carry out day-to-day field surveillance (FSM 3411). Stand examinations, inventories and other activities afford

excellent opportunities for forest workers to note and record the presence of H. annosum.

A systematic search for diagnostic symptoms of infection and signs of the pathogen, determines the presence of H annosum. Use the following similar symptoms for correct diagnosis:

a. Pattern of Dying Within the Stand. Root pathogens tend to kill trees over a period of years, with oldest deaths at the center, usually around stumps, and recently dead and dying trees at the margin. In contrast, a characteristic of mortality by bark beetles alone is groups of trees dying at about the same time.

b. Pattern of Dying of Individual Trees. Trees with root disease die gradually, with symptoms progressing from the bottom of the crown upwards, and from the inside of the crown out. Infection of the roots causes: (1) reduced height growth, with crowns becoming rounded; (2) thin and chlorotic crowns, resulting from poor needle retention; and (3) subsequent insect attack of the stressed trees.

c. Symptoms and Signs in Roots and Root Crowns. Use symptoms and signs in roots and root crowns to determine the specific identity of the pathogen. The best evidence of H. annosum is the presence of characteristic fruiting bodies or conks. The annual to perennial, leathery conks vary in size and shape from small button-shaped or "popcorn" conks on the root surface of recently killed seedlings or saplings, to large bracket-type conks. The large conks generally have a light brown to gray upper surface, and a creamy white lower surface with regularly spaced, small pores. Small "popcorn" conks appear as small buff-colored pustules that range in size from a pinhead to a dime. They often have no pore layer. In pines, the conks are found between the bark and wood on stumps, beneath the duff layer at the root crown, and within old stumps. In true fir, the conks are found in cavities hollowed out by the fungus. Conks may be abundant in some stands and scarce or absent in others. Even when present, they can be easily overlooked because of their inconspicuous color and obscure location. Refer to Hadfield, et al. 1986 and Smith 1993 for color photographs of conks.

On pines, additional symptoms may be found by exposing the roots and root crown and examining the inner bark. Choose recently killed or dying trees for examination. Indications of H. annosum infection are: (1) easy separation of the bark from the wood; (2) the separated surfaces are a light brown to buff color, the surface of the wood streaked with darker brown lines; and (3) numerous small silver to white flecks on the surface of the inner bark. Resin often heavily infiltrates infected roots.

Incipient or early stages of wood decay are not very diagnostic. Discoloration may or may not be present and the heartwood remains firm and hard. As the decay progresses, the

wood becomes white to straw yellow, separates along annual rings, and may contain elongated white pockets.

If field personnel are unable to identify H. annosum with certainty, or desire confirmation of a tentative identification, the Forest Pest Management Group can assist. Gather specimens of infected root tissue in various stages of decay and any fruiting bodies and send them to FPM pathologists in the Service Areas, or to pathologists in the Regional Office. The specimens must be of tissues in early stages of decay to enable isolation of the pathogen. A completed Forest Pest Detection Report (Form R5-3400-1) shall accompany the samples.

5. Detection Surveys. Personnel may conduct detection surveys (FSM 3412) in areas where no other surveys are scheduled and it is essential that the presence or absence of annosus root disease be known for management purposes. The objective of a detection survey is simply to determine the presence and location of H. annosum.

Because annosus root disease is not always obvious and can be difficult to detect, contact the Forest Pest Management Group with a request to conduct the survey if H. annosum has the potential to adversely affect activities or interfere with resource objectives.

6. Evaluation. The purpose of a biological evaluation (FSM 3421) is to provide information for the resource manager on annosus root disease infestations, their affects on the stand, the management alternatives appropriate in the context of the particular resource management objectives, and the future affects of each alternative. The Forest Pest Management Group or field personnel shall conduct biological evaluations of annosus root disease. Submit requests for a biological evaluation by sending a Forest Pest Detection Report (Form R5-3400-1) or written request to the Regional Forester or FPM Program Leader, or to one of the Service Areas. Field units shall coordinate requests through the appropriate line officer.

7. Management Strategies. Use the integrated pest management (IPM) approach to manage annosus root disease and other pests. IPM involves regulating the pest, the host, and the environment to minimize pest impacts on resource management objectives in ecologically and economically sound ways. Also, use the IPM approach to implement and coordinate activities needed to prevent or suppress pest-related problems. This approach also emphasizes the selection, integration, and use of a variety of tactics on the basis of anticipated economic and ecological consequences. Accomplish control of annosus root disease by prevention of new disease centers, thereby decreasing the risk of stump and wound infection, and through silvicultural manipulation of infested stands to minimize the impact of the disease.

8. Prevention. Prevention (FSM 3406.1) includes activities designed to minimize the impact of a pest before it appears. The objective of annosus root disease prevention is to prevent establishment of the disease in stands. Once annosus root disease becomes established in most forest stands, no economically feasible procedure for directly suppressing the disease is available. Therefore, prevention is the most efficient and economical method of reducing the impact of H. annosum.

Prevention of annosus root disease includes treatment of freshly-cut conifer stumps with registered products. Other preventive treatments include carrying out silvicultural activities to lessen stand susceptibility to the disease, and minimizing logging damage and mechanical injuries.

9. Stump Treatment. Personnel can reduce the probability of infection of freshly cut conifer stumps by the use of a surface stump treatment with registered products. Contact Forest Pest Management for currently registered and effective materials. Treatment of freshly cut conifer stumps with two borate products (sodium tetraborate decahydrate and sodium octaborate tetrahydrate) indicate at least 90% efficacy in preventing infection. The borate in the formulations is toxic to the spores of the fungus and prevents germination; it does not have an effect on existing infections. Apply the products according to label directions. For maximum effectiveness, it is imperative to apply the material as soon after felling as practical and that the application cover the entire stump surface and other areas where the bark has been knocked off. The requirement for application in timber sales and other non-force account work shall be part of the contract or cooperative agreement. A Regional C provision is available for inclusion in timber sale contracts.

R-5 FSM 2303 requires treatment of all conifer stumps in recreation sites. The same direction shall apply to other high value areas, such as progeny test sites, seed orchards, and areas of high value trees, such as giant sequoia groves. In eastside pine or mixed conifer type stands, where surveys have indicated high levels of annosus root disease, treatment of conifer stumps 12 inches or greater in diameter is highly recommended during chainsaw felling. When mechanical shearers are used, the minimum diameter should be reduced to 8 inches. These areas include the eastside pine and eastside mixed conifer types on the Modoc, Lassen, Plumas, Tahoe, Sequoia and Inyo National Forests; the Goosenest Ranger District, Klamath National Forest; and the McCloud Ranger District, Shasta-Trinity National Forests.

In all other areas, consider stump treatments on an individual stand basis. The line officer is responsible for the decision to treat freshly cut conifer stumps, and shall base that decision on information available for the specific situation in the particular stand in question. This information should include:

a. The objectives and management direction for the stand.

b. The level of annosus root disease currently in the stand or in nearby similar stands, determined by an examination of stumps for evidence of H. annosum and indications of infection in living trees.

c. An estimate of the cost-effectiveness of the treatment.

d. A Forest Pest Management biological evaluation or an on-site visit.

10. Avoiding Cambial Damage. In addition to being an aggressive colonizer of freshly-cut stumps, H. annosum can also act as a wound

parasite by attacking living trees through injuries that expose cambial tissue. The fungus, as well as other decay fungi, are likely to colonize logging injuries, especially those in contact with the ground. Trees with nonresinous wood, such as true fir and hemlock, are more likely to be infected following injury and to have more extensive decay than species with resinous wood, such as Douglas-fir and the pines. Decay caused by H. annosum is common behind fire scars and other basal wounds in true fir. It may be possible to minimize losses by preventing fires that expose cambium when underburning for fuels reduction, and by reducing mechanical injuries during stand entries.

Other methods of prevention have been suggested, but consider these methods experimental until there is demonstrated efficacy under California conditions. These experimental methods include: (1) thinning during the hotter summer months; (2) creation of high stumps, and, (3) control of stocking density in true fir stands.

11. Suppression. Suppression (FSM 3406.2) of annosus root disease includes the reduction of damage to acceptable or tolerable levels. Direct suppression procedures for H. annosum, such as stump removal, creation of buffer strips, and soil fumigation, are costly and considered experimental. Indirect suppression options, that is, those that alter conditions favoring the pest through the application of silvicultural methods of stand manipulation, are available. These methods include species conversion, thinning in true fir stands, and in recreation areas, thinning and interplanting with hardwoods.

a. Species Conversion. Because of host specificity of the 'S' and 'P' types of H. annosum, favor the non-infected host species (see item 2.a.). In mixed conifer stands with infected true firs, the stand my be converted to pines and incense-cedar with little risk of subsequent infection. If pines are infected, favor true fir. In recreation areas, favor existing hardwoods or the non-infected conifer species. Since hardwoods are resistant, the fungus will eventually die out over a period of 2 to 4 decades, depending on stump size. Then, take steps to regenerate the conifers.

b. Thinning in True Fir Stands. Field observations suggest that removal of slow growing fir and thinning of overstocked stands to increase tree vigor may reduce the impact of the disease, given that the residual trees are capable of responding to release.

c. Revegetate Disease Centers. If consistent with site-specific objectives, resistant species can be used to revegetate active annosus centers. Leaving the centers barren or revegetating with hardwoods will allow the fungus to eventually die out over a period of several decades or more. Favoring hardwoods already present and planting suitable hardwoods provides a barrier of nonsusceptible roots that may limit the spread of infection centers. Thin dense pole-sized stands of susceptible conifers and interplant with hardwoods. Doing this minimizes opportunities for root contact and reduces the risk of further spread. It also increases tree vigor, which reduces risk of bark beetle attack.

d. Stump Removal. Removal of stumps and roots infected with H. annosum would reduce the amount of inoculum of the fungus on the site, and allow for earlier successful revegetation of the site with susceptible conifers. Stump removal as a suppressive method is being tested in several recreation sites, and its efficacy has not yet been demonstrated.

REFERENCES

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WILBUR-ELLIS

SPORAX

A BORAX FUNGICIDE
FOR CONTROL OF ANNOSUS ROOT DISEASE

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMAN AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed. Wash thoroughly after handling. Avoid contamination of food and feed.

Do not leave container where children or animals may gain access.

PERSONAL PROTECTIVE EQUIPMENT

Applicators and other handlers must wear: Long-sleeved shirt and long pants, shoes, socks and waterproof gloves.

DIRECTIONS FOR USE:

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

USE FOR CONTROL OF ANNOSUS ROOT DISEASE IN CONIFER STANDS

It has been established that the fungus, *Heterobasidion annosum*, often infects cut conifer stumps following thinning or cutting operations, and that the disease can spread from infected stumps to residual trees in the stand.

Several chemical agents have been used to limit the development of annosus root disease. Research has shown that Borax prevents establishment and growth of annosus in cut stumps of conifer tree species not already infected.

Before using WILBUR-ELLIS SPORAX for stump treatment control of annosus infection, contact Local, State or Federal Forestry or plant pathology specialists to verify the most economical and efficient methods and materials for your situation.

Use of WILBUR-ELLIS SPORAX for this purpose includes all conifer tree species occurring in the stand being treated. WILBUR-ELLIS SPORAX should be applied to stump surface of the cut tree as soon after felling as practical. For most efficient use, apply immediately after cutting, but avoid delaying treatment more than one day.

The best method of application is to sprinkle the material "salt-shaker" style on the freshly cut stump surface. Complete coverage, including exposed side areas and any splinters, is necessary. Also level rather than sloping stump surfaces are preferred, especially in areas of high rainfall. "Shaker-top" applicators are available in most farm and garden shops in one or two pound sizes.

Apply enough WILBUR-ELLIS SPORAX to lightly cover entire stump surface. At proper rates of application one pound of this product will adequately cover 50 square feet of stump surfaces; that is, 200 six-inch stumps, 156 eight-inch stumps, 80 ten-inch stumps, or 50 twelve-inch stumps.

Moisture in the exposed wood from freshly cut stumps, dew, or rain, will dissolve the product and leach it into the wood.

STORAGE AND DISPOSAL

1. **PROHIBITIONS:** Do not contaminate water, food or feed by storage or disposal. Do not store where children or animals may gain access. Open burning and dumping prohibited. Do not reuse empty container.
2. **PESTICIDE DISPOSAL:** Pesticide, spray mixture or rinsate that cannot be used or chemically reprocessed should be disposed of according to procedures approved by Federal, State or Local disposal authorities.
3. **CONTAINER DISPOSAL:** Consult Federal, State or Local disposal authorities for approved procedures.

ACTIVE INGREDIENT

SODIUM TETRABORATE DECAHYDRATE ($Na_2B_4O_7 \cdot 10H_2O$)	100%
Boric Oxide (B_2O_3) equivalent	37.50%)

EPA Reg. No. 2935-501 EPA Est. No. 2935-CA-1

KEEP OUT OF REACH OF CHILDREN

DANGER

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED, immediately contact a physician or Poison Control Center. If these are unavailable, give the victim 1 or 2 glasses of water and induce vomiting by touching the back of the throat with fingers. Do not induce vomiting or give anything by mouth to an unconscious person.

IF IN EYES, flush with plenty of water. Get medical attention if irritation persists.

IF ON SKIN, remove contaminated clothing and wash skin with soap and water.

IF INHALED, remove victim to fresh air.

NOTICE: The statements made on this label are believed to be true and accurate, but because of conditions of use which are beyond our control, WILBUR-ELLIS COMPANY does not make, nor does it authorize any agent or representative to make any warranty, guarantee or representation, expressed or implied, concerning the material or the use thereof, except in conformity with the statements on the label. Neither WILBUR-ELLIS COMPANY nor the seller shall be held responsible in any manner for any personal injury or property damage or loss resulting to the buyer or to the other person from handling, storage, or use of this material, not in accordance with directions. The buyer assumes all risk and liability resulting from improper handling, storage, or use and accepts and uses this material on these conditions.

WILBUR-ELLIS® and IDEAS TO GROW WITH® are trademarks of WILBUR-ELLIS Company

F-784

NET WEIGHT: 50 POUNDS

IN CASE OF EMERGENCY, CALL CHEMTREC: (800) 424-9300

WILBUR-ELLIS
IDEAS TO GROW WITH®

P.O. BOX 16458 • FRESNO, CALIFORNIA 93755

NOT REGISTERED IN CALIFORNIA

SPECIMEN LABEL

MATERIAL SAFETY DATA SHEET

WILBUR-ELLIS COMPANY
P.O. BOX 16458
FRESNO, CA 93755

EMERGENCY TELEPHONE NUMBER
(209) 226-1934

24 HOUR EMERGENCY TELEPHONE NUMBER
CHEMTREC: (800) 424-9300

SECTION 1 NAME
PRODUCT/TRADE NAME: SPORAX
EPA REGISTRATION #: 2935-501
CHEMICAL NAME/COMMON NAME:
Sodium Tetraborate Decahydrate

SECTION 2 HAZARDOUS INGREDIENTS

		CAS#	OSHA PEL	ACGIH TLV
Sodium Tetraborate Decahydrate	100%	1303-96-4	NE	NE

SECTION 3 PHYSICAL DATA
SPECIFIC GRAVITY (H2O = 1): 1.73
MELTING POINT: 62 Deg. C
VAPOR DENSITY (AIR = 1): NA
% VOLATILES BY VOL.: NA
ODOR: None
APPEARANCE: White Crystaline Solid
FLASH POINT/METHOD: NA
VAPOR PRESSURE (mmHg): NA
SOLUBILITY IN H2O: Partially

SECTION 4 FIRE & EXPLOSION HAZARD
EXTINGUISHING MEDIA: [ ] Water Fog [ ] Foam [ ] Alcohol Foam [ ] CO2 [ ] Dry Chemical [X] Other

---

FIRE FIGHTING PRECAUTIONS & HAZARDS:
This product is not flammable. It also can act as a fire retardant.

SECTION 5 CARCINOGEN STATUS
[ ] OSHA [ ] NTP [ ] IARC
[X] No Listing Type

SECTION 6 REACTIVITY
[X] Stable
[ ] Unstable

HAZARDOUS POLYMERIZATION
[ ] May Occur [X] Will Not Occur

AVOID:
Elemental Zircon

HAZARDOUS DECOMPOSITION PRODUCTS:
NA

SECTION 7 SPILL OR LEAK PROCEDURES
STEPS TO BE TAKEN IN CASE OF SPILL:
Vacuum or sweep material up and reuse or place in a disposal container.
DECONTAMINATION:
Treat area with detergent and water. Repeat as necessary until area is clean.
ENVIRONMENTAL HAZARDS:
Dike to prevent entering drains, sewers or water courses.
DISPOSAL:

Dispose of in accordance with federal, state and local regulations.

SECTION 8 HEALTH PRECAUTION DATA

INGESTION:
Acute oral LD50 (rat) 6.13 g/kg (U.S. Borax). Do not ingest. Wash thoroughly before eating, drinking or smoking.

INHALATION:
May cause slight nasal irritation.

SKIN ABSORPTION:
Not expected to cause irritation.

EYE EXPOSURE:
May cause slight eye irritation. Wear proper eye protection to prevent exposure.

EFFECTS OF OVEREXPOSURE:
Symptoms of overexposure are sneezing, coughing and eye irritation. Ingestion may cause nausea, vomiting, diarrhea and facial flushing.

FIRST AID:
In all cases get prompt medical attention. If ingested, give several glasses of water and induce vomiting. Do not induce vomiting if victim is unconscious. For skin exposure, wash with water. For eye exposure, irrigate a minimum of 15 minutes with water. If inhaled, remove to fresh air.

SECTION 9 SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:
Use NIOSH/MSHA approved respiratory protection for nuisance particulates.

PERSONAL PROTECTIVE EQUIPMENT:
Safety goggles or glasses with side shields and brow protection.

VENTILATION:
Local exhaust ventilation recommended for control of nuisance dust.

SECTION 10 SPECIAL PRECAUTIONS

Keep out of the reach of children.
Read and follow all label instructions.

SECTION 11 REGULATORY DATA

SARA HAZARD CLASS:	[ ] Acute	[ ] Chronic	[ ] Flammable
	[ ] Pressure	[ ] Reactive	[X] None
SARA 313:	[ ] Yes	[X] No	Chemical:			
SARA 302:	[ ] Yes	[X] No	Chemical:			
	TPQ:					
CERCLA:	[ ] Yes	[X] No	Chemical:			
	RQ:					
RCRA:	[ ] Yes	[X] No				

NFPA Hazard Rating:
Health: [0]

NFPA Hazard Rating Scale:
0=Minimal 3=Serious

Fire:	[0]	1=Slight 4=Severe
Reactivity:	[0]	2=Moderate
Special:	[ ]	
HMIS Codes:		HMIS Hazard Rating Scale:
Health:	[0]	0=Minimal 3=Serious
Fire:	[0]	1=Slight 4=Severe
Reactivity:	[0]	2=Moderate

DATE PREPARED:
DATE PREPARED: March 31, 1993
REVISED DATE:
Notice: This information was developed from information on the constituent materials. No warranty is expressed or implied regarding the completeness or continuing accuracy of the information contained herein, and Wheelabrator Shasta Energy Company, Inc., disclaims all liability for reliance thereon. The user should satisfy himself that he has all current data relevant to his particular use.
*Technical Material NE - Not Established NA - Not Applicable

M A T E R I A L S A F E T Y D A T A S H E E T

WILBUR-ELLIS COMPANY
P.O. BOX 16458
FRESNO, CA 93755

EMERGENCY TELEPHONE NUMBER
(209) 226-1934

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		CAS#	OSHA PEL	ACGIH TLV
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SARA 302:	[ ] Yes	[X] No	Chemical:					
	TPQ:							
CERCLA:	[ ] Yes	[X] No	Chemical:					
	RQ:							
RCRA:	[ ] Yes	[X] No						

NFPA Hazard Rating:
Health: [0]

NFPA Hazard Rating Scale:
0=Minimal 3=Serious

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Reactivity:	[0]	2=Moderate	
Special:	[ ]		
HMIS Codes:		HMIS Hazard Rating Scale:	
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Reactivity:	[0]	2=Moderate	

DATE PREPARED:
DATE PREPARED: March 31, 1993
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*Technical Material NE - Not Established NA - Not Applicable

03/07/95 14:27 2092267630 WILBUR-ELLIS NOT REGISTERED IN CALIFORNIA 006/009
SPECIMEN LABEL

WILBUR-ELLIS

SPORAX

A BORAX FUNGICIDE
FOR CONTROL OF ANNOSUS ROOT DISEASE

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMAN AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed. Wash thoroughly after handling. Avoid contamination of food and feed.

Do not leave container where children or animals may gain access.

PERSONAL PROTECTIVE EQUIPMENT

Applicators and other handlers must wear: Long-sleeved shirt and long pants, shoes, socks and waterproof gloves.

DIRECTIONS FOR USE:

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

USE FOR CONTROL OF ANNOSUS ROOT DISEASE IN CONIFER STANDS

It has been established that the fungus, *Heterobasidion annosum*, often infects cut conifer stumps following thinning or cutting operations, and that the disease can spread from infected stumps to residual trees in the stand.

Several chemical agents have been used to limit the development of annosus root disease. Research has shown that Borax prevents establishment and growth of annosus in cut stumps of conifer tree species not already infected.

Before using WILBUR-ELLIS SPORAX for stump treatment control of annosus infection, contact Local, State or Federal Forestry or plant pathology specialists to verify the most economical and efficient methods and materials for your situation.

Use of WILBUR-ELLIS SPORAX for this purpose includes all conifer tree species occurring in the stand being treated. WILBUR-ELLIS SPORAX should be applied to stump surface of the cut tree as soon after felling as practical. For most efficient use, apply immediately after cutting, but avoid delaying treatment more than one day.

The best method of application is to sprinkle the material "salt-shaker" style on the freshly cut stump surface. Complete coverage, including exposed side areas and any splinters, is necessary. Also level rather than sloping stump surfaces are preferred, especially in areas of high rainfall. "Shaker-top" applicators are available in most farm and garden shops in one or two pound sizes.

Apply enough WILBUR-ELLIS SPORAX to lightly cover entire stump surface. At proper rates of application one pound of this product will adequately cover 50 square feet of stump surfaces; that is, 260 six-inch stumps, 158 eight-inch stumps, 80 ten-inch stumps, or 60 twelve-inch stumps.

Moisture in the exposed wood from freshly cut stumps, dew, or rain, will dissolve the product and leach it into the wood.

STORAGE AND DISPOSAL

1. **PROHIBITIONS:** Do not contaminate water, food or feed by storage or disposal. Do not store where children or animals may gain access. Open burning and dumping prohibited. Do not reuse empty container.
2. **PESTICIDE DISPOSAL:** Pesticide, spray mixture or rinsate that cannot be used or chemically reprocessed should be disposed of according to procedures approved by Federal, State or Local disposal authorities.
3. **CONTAINER DISPOSAL:** Consult Federal, State or Local disposal authorities for approved procedures.

50078

ACTIVE INGREDIENT

SODIUM TETRABORATE DECAHYDRATE ($Na_2B_4O_7 \cdot 10H_2O$)	100%
Boric Oxide (B_2O_3) equivalent	37.50%

EPA Reg. No. 2935-501 EPA Est. No. 2935-CA-1

KEEP OUT OF REACH OF CHILDREN

DANGER

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED, immediately contact a physician or Poison Control Center. If these are unavailable, give the victim 1 or 2 glasses of water and induce vomiting by touching the back of the throat with fingers. Do not induce vomiting or give anything by mouth to an unconscious person.

IF IN EYES, flush with plenty of water. Get medical attention if irritation persists.

IF ON SKIN, remove contaminated clothing and wash skin with soap and water.

IF INHALED, remove victim to fresh air.

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F-784

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